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2012
THIRD QUARTER

Business Appraisal Practice

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Further Insights While Applying Statistical Procedures to the Transaction Databases: A Reply to C. Frederick Hall, III

Mark G. Filler, CPA/ABV, CBA, AM, CVA

C. Fred Hall had an excellent article in the 2012 Second Quarter issue of *Business Appraisal Practice* entitled "Using Regression Analysis in the Market Approach," which discussed two regression models that consider a company's degree of profitability: the Price/Revenue vs. Seller's Discretionary Earnings (SDE)/Revenue model and the Price/SDE vs. SDE/Revenue model. His article provoked in me the following question: if you wouldn't pay the same price for two different companies, both with sales of $1,000,000 but one with SDE of $350,000 and the other with SDE of $200,000, would you pay the same price for two companies both with SDE of $300,000 but one with sales of $1,000,000 and the other with sales of $750,000? That is, what attracts a higher price – cash flow or revenue? Coincident with this question is another – which valuation model gives the more appropriate answer? This article will explore the answers to both those questions. But first we need to respond to some ideas put forth by Mr. Hall that if used in your valuation work could lead to a successful *Daubert* challenge.

Mr. Hall is certainly correct when he states that the application of measures of central tendency (be it the mean, the median or the weighted harmonic mean) to above-average or below-average size companies results in anomalous valuations. He is also correct when he concludes that companies that are relatively more profitable will sell for higher multiples of revenue. However, I do not think he is correct when he suggests that the inverted relationship between return on sales (ROS), or SDE% and the SDE multiple is a paradox, when in fact it is nothing more than a function of simple arithmetic. For example, in the model Price/SDE vs. SDE/Revenue, if we substitute the following numerical terms into the model, 300/80 vs. 80/1000, we get a ratio of 3.75 vs. .08. As 80 is the numerator of one ratio and the denominator of the other, an increase in SDE of 10 will produce new ratios of 3.33 and .09, respectively, indicating that as ROS increases the revenue multiplier decreases. But this is because as one ratio increases, arithmetically the other must necessarily decrease, and *vice-versa*. There is nothing paradoxical about this and it requires no further investigation or understanding.

The next idea of Mr. Hall's that I take issue with is that of an alleged size effect in the transaction databases as shown in his Exhibit III. What we have here is known technically as the Ecological Correlation Fallacy, which states that the variability of individuals is much greater than the variability of their mean. I go into this in more detail and explain its derivation and ramifications in my accompanying article in this issue entitled "The Bizcomps Database, the Size Effect Phenomenon and a Necessary and Sufficient Sample Size: A Response to Toby Tatum." But let's take a brief moment and explore this idea with the 23 machine shop transactions presented in Mr. Hall's Exhibit I. As shown on my Figure 1, if we sort by size using gross revenue as our size determinant, then apportion the values in the Cash Flow (SDE) Multiplier column into 4 quartiles and finally run a pairwise means difference test, we find that although the averages of the 4 quartiles are 2.74, 4.46, 3.65 and 2.60, respectively, because of the high degree of variability in the data there is no statistical difference among the 4 averages. Therefore, we can reject the notion of a purported size effect for this set of transactions as none of the pairwise probabilities comes close to the .05 level of significance. We can now turn our attention to the two questions posed above.

Serendipitously, the procedures needed to answer the first question are the same procedures that will answer the second question, so we have only to construct one group of valuation models. But we must first choose which models to test. Obviously, we will include the two regression models cited above: Price/Revenue vs. SDE/Revenue and Price/SDE vs. SDE/Revenue; the first because a revenue multiplier must be moderated by degree of profitability, and the second to test whether absolute profitability need be moderated by degree of profitability to become a better predictor of value. The second set of models will be the weighted harmonic mean of the Price/Revenue and Price/SDE ratios. The final set will be simple linear regression models of Price regressed against Revenue, and Price regressed against SDE. This gives us a total

of six models to compare and contrast using as source data the 23 machine shop transactions featured in Mr. Hall's article.

Something that all six models have in common is the need to have their data scrubbed by removing outliers, i.e., those transactions whose residual (the difference between actual and predicted values) is more than 2.5 standard deviations from the predicted trendline. This outlier removal process is shown on Figure 2 for the model that regresses Price/Revenue against SDE/Revenue and on Figure 3 for the weighted harmonic mean of the Price/Revenue ratio model. Similar procedures would be applied to the other three regression models and the weighted harmonic mean Price/SDE ratio model. Various statistics of the six models after the outlier removal process is completed are shown in Panel A of Figure 4. The model with the best metrics, i.e., the lowest coefficient of variation and root-mean-square error (RMSE) and the highest R^2, is the weighted harmonic mean of the Price/SDE ratio – perhaps because it took the removal of six transactions to stabilize the model, and *ceteris paribus*, we would prefer a model with fewer outliers removed, not the maximum. While a high R^2 and a low RMSE and coefficient of variation are neither necessary nor sufficient to determine the model of choice, they are a good place to start. Therefore, we should pay close attention to the values produced by the two highest ranked models--the weighted harmonic mean of the Price/SDE ratio and the Price/SDE vs. SDE/Revenue regression model.

Panel B of Figure 4 shows two hypothetical companies, each with the same revenue of $1,000,000 but with different amounts of SDE – Panel B1 contains SDE of $350,000 and Panel B2 contains SDE of $200,000. Panel C of Figure 4 shows two hypothetical companies, each with the same SDE of $300,000 but with different amounts of revenue – Panel C1 contains revenue of $1,000,000 and Panel C2 contains revenue of $750,000. While no pattern or trend is obvious in any of the four panels, some observations and comments are in order.

It is readily apparent on Figure 4 that a pure revenue model, either ratio or regression, will rarely produce an appropriate value for a subject company, as these models cannot consider relative profitability. Comparing the values produced by these two models to the other four models in all four panels on Figure 3 shows the large differences between the two groups that makes this point obvious.

Turning our attention to the weighted harmonic mean of the Price/SDE model we can see a demonstration of the point made by Mr. Hall that ratio models are unreliable if the subject company's SDE strays too far from the database average. For example, in Panels B1 and B2 when SDE changes from 350,000 to 200,000, value changes by 437,423 for the weighted harmonic mean – Price/

Figure 1

Pairwise Means Difference Test			
Gross Revenue Quartiles (Sorted by Size)			
1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
505,000	875,000	979,000	1,205,000
550,000	876,000	1,000,000	1,220,000
572,000	877,000	1,021,000	1,222,000
714,000	950,000	1,050,000	1,279,000
774,000	959,000	1,113,000	1,490,000
774,000	975,000	1,156,000	
Corresponding Price/SDE Multiple Quartiles			
1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
3.37	7.61	3.59	4.12
2.76	5.95	5.20	1.75
2.45	1.81	3.41	2.16
2.45	4.96	3.75	2.69
2.93	2.10	3.44	2.29
2.48	4.30	2.48	

Price/SDE Multiple Descriptive Statistics				
	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Count	6	6	6	5
Average	2.74	4.46	3.65	2.60
Standard Deviation	0.37	2.24	0.88	0.91
Sum of Squares	45.75	144.14	83.66	37.15
Pairwise Mean Difference (row - column)				
	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
1st Quartile	0.000	-1.715	-0.906	0.140
2nd Quartile		0.000	0.809	1.855
3rd Quartile			0.000	1.046
4th Quartile				0.000
Pairwise Probabilities				
	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
1st Quartile	-	0.215	1.000	1.000
2nd Quartile		-	1.000	0.186
3rd Quartile			-	1.000
4th Quartile				-

Figure 2

Price/SDE vs. SDE/Revenue Regression Model - Outlier Removal Worksheet

Observation	Selling Price	Gross Revenue	SDE	Price/SDE	SDE/Rev	Modified Price/SDE Multiple	Residual	Standardized Residual	X if >2.5	Predicted Selling Price
1	300,000	1,050,000	80,000	3.75	0.08	3.51	(0.237)	-0.289		281,073
2	422,000	950,000	85,000	4.96	0.09	3.47	(1.492)	-1.824		295,193
3	305,000	774,000	104,000	2.93	0.13	3.34	0.403	0.493		346,923
4	515,000	1,490,000	225,000	2.29	0.15	3.29	0.996	1.218		739,125
6	305,000	774,000	123,000	2.48	0.16	3.26	0.781	0.955		401,086
7	600,000	979,000	167,000	3.59	0.17	3.23	(0.368)	-0.450		538,615
8	301,000	877,000	166,000	1.81	0.19	3.17	1.355	1.657		525,913
10	768,000	1,113,000	223,000	3.44	0.20	3.13	(0.310)	-0.379		698,955
11	1,050,000	1,205,000	255,000	4.12	0.21	3.10	(1.018)	-1.245		790,489
12	750,000	1,279,000	279,000	2.69	0.22	3.08	0.392	0.479		859,333
13	345,000	550,000	125,000	2.76	0.23	3.05	0.292	0.357		381,520
15	385,000	572,000	157,000	2.45	0.27	2.91	0.456	0.557		456,564
16	1,225,000	975,000	285,000	4.30	0.29	2.85	(1.445)	-1.767		813,279
17	570,000	505,000	169,000	3.37	0.33	2.72	(0.648)	-0.793		460,412
18	971,000	1,156,000	391,000	2.48	0.34	2.71	0.230	0.281		1,060,937
19	682,000	959,000	325,000	2.10	0.34	2.71	0.613	0.750		881,199
20	600,000	714,000	245,000	2.45	0.34	2.70	0.249	0.305		661,115
21	1,182,000	1,222,000	547,000	2.16	0.45	2.38	0.219	0.267		1,301,545
22	1,565,000	1,021,000	459,000	3.41	0.45	2.37	(1.036)	-1.267		1,089,448
23	1,000,000	1,220,000	572,000	1.75	0.47	2.31	0.566	0.693		1,323,964
Average	692,050	969,250	249,100	2.965	0.256	2.965				695,334
CoV				27.6%						29.7%
Constant		3.746								
Slope		-3.053								
RMSE (SEE)		0.818								205,318
R^2		0.169								0.688
Outliers										
5	1,012,000	875,000	133,000	7.609	0.152	3.28	(4.327)	-5.292	X	
9	1,000,000	876,000	168,000	5.952	0.192	3.16	(2.792)	-3.414	X	
14	1,300,000	1,000,000	250,000	5.200	0.250	2.98	(2.217)	-2.711	X	

SDE model, while the other three non-revenue models have a spread of 273,000 to 310,000.

The other problematic model is the Price/SDE vs. SDE/Revenue regression model. There is a theoretical reason as to why a dollar of cash flow should be worth more or less depending upon the subject company's ROS. When performing a capitalized cash flow or DCF income method, we make no adjustment to cash flow to equity or invested capital that accounts for relative profitability, but we do adjust the cost of equity for the degree of operating leverage the subject company bears relative to its industry peers. Therefore, it makes sense to use a regression model that does the same thing for the market approach. However, when we look at Panels C1 and C2, even if ROS increases, because revenue decreases, so does the subject company value – a result at odds with the theory. While the model is supposed to consider ROS as the determinant value factor, it seems to place more emphasis on revenue volume than either absolute or relative profitability. This makes the model inherently unreliable, and I would urge anyone that uses it to be very cautious of the results obtained.

Of course, none of these market approach models should be used in a vacuum. The model selection process must

Figure 3

Weighted Harmonic Mean Price/Revenue Model - Outlier Removal Worksheet								
Observation	**Selling Price**	**Gross Revenue**	**Revenue Multiplier**	**SDE**	**Predicted Selling Price**	**Residual**	**Standardized Residual**	**X if > 2.5**
1	300,000	1,050,000	0.29	80,000	775,155	(475,155)	-1.551	
2	422,000	950,000	0.44	85,000	701,331	(279,331)	-0.912	
3	305,000	774,000	0.39	104,000	571,400	(266,400)	-0.870	
4	515,000	1,490,000	0.35	225,000	1,099,982	(584,982)	-1.909	
5	1,012,000	875,000	1.16	133,000	645,963	366,037	1.195	
6	305,000	774,000	0.39	123,000	571,400	(266,400)	-0.870	
7	600,000	979,000	0.61	167,000	722,740	(122,740)	-0.401	
8	301,000	877,000	0.34	166,000	647,439	(346,439)	-1.131	
9	1,000,000	876,000	1.14	168,000	646,701	353,299	1.153	
10	768,000	1,113,000	0.69	223,000	821,664	(53,664)	-0.175	
11	1,050,000	1,205,000	0.87	255,000	889,583	160,417	0.524	
12	750,000	1,279,000	0.59	279,000	944,213	(194,213)	-0.634	
13	345,000	550,000	0.63	125,000	406,034	(61,034)	-0.199	
14	1,300,000	1,000,000	1.30	250,000	738,243	561,757	1.834	
15	385,000	572,000	0.67	157,000	422,275	(37,275)	-0.122	
16	1,225,000	975,000	1.26	285,000	719,787	505,213	1.649	
17	570,000	505,000	1.13	169,000	372,813	197,187	0.644	
18	971,000	1,156,000	0.84	391,000	853,409	117,591	0.384	
19	682,000	959,000	0.71	325,000	707,975	(25,975)	-0.085	
20	600,000	714,000	0.84	245,000	527,105	72,895	0.238	
21	1,182,000	1,222,000	0.97	547,000	902,133	279,867	0.914	
23	1,000,000	1,220,000	0.82	572,000	900,656	99,344	0.324	
Average	708,545	959,773	0.75	230,636				
CoV				43.24%				
RMSE				306,360				
R^2				0.179				
ROS				23.91%				
Weighted Harmonic Mean Price/Revenue				0.74				
Outliers								
22	1,565,000	1,021,000	1.53	459,000	753,746	811,254	2.648	X

include a matchup of results with those independently obtained from the income approach in order to narrow down the choices. This process will inevitably lead to a state of reciprocal influences – the market approach results will cause you to reconsider your initial ideas about cash flow, growth rates and the cost of equity.

We can now return to the two questions asked in the first paragraph above – does SDE or revenue attract a higher price, and which valuation model gives the more appropriate answer? The answer to both questions is the same – it depends! Each situation is different, and context is everything. Is your subject company above or below the database average for revenue, SDE and ROS? The answer to those questions will determine which model(s) you choose and the value(s) they will give you. As for myself, the Price/SDE regression model is typically chosen, except when revenues are average or above and SDE and ROS are below average. Then the regression model Price/Revenue vs. SDE/Revenue produces more realistic results.

While it is impossible to automate the valuation process, the application of reasonableness, informed judgment and common sense can be aided and abetted by the procedures, steps and models presented in this article.

Figure 4

Summary Output of Various Models

Panel		Regression Price/SDE vs. SDE/Revenue	Regression Price/Revenue vs. SDE/Revenue	Ratio Weighted Harmonic Mean - Price/SDE	Ratio Weighted Harmonic Mean - Price/Revenue	Regression Price vs. Revenue	Regression Price vs. SDE
A	**Outliers Removed**	3	0	6	1	1	0
	Back-Transformed:						
	RMSE	205,318	277,229	156,310	306,360	310,679	277,211
	Coefficient of Variation	29.67%	37.17%	25.47%	43.24%	43.85%	37.17%
	R^2	0.688	0.463	0.788	0.179	0.179	0.472
	Regression Constant	3.746	0.330			167,731.87	301,037.12
	Regression X coefficient	-3.053	1.818			0.563	1.849
	Ratio Multiple			2.92	0.74		
	Data Set Averages						
	Revenue	969,250	962,435	939,294	959,773	959,773	962,435
	SDE	249,100	240,565	210,471	230,636	230,636	240,565
	ROS	25.57%	24.82%	22.98%	23.91%	23.91%	24.82%
B1	**Subject Company (Above Average Revenue, SDE and ROS)**						
Same Revenue, Different SDE	Multiplier	2.677	0.966	2.92	0.74		
	Revenue	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
	SDE	350,000	350,000	350,000	350,000	350,000	350,000
	ROS	35.00%	35.00%	35.00%	35.00%	35.00%	35.00%
	PredictedValue	937,117	966,082	1,020,654	738,243	731,213	948,100
B2	**Subject Company (Above Average Revenue, Below Average SDE and ROS)**						
Same Revenue, Different SDE	Multiplier	3.135	0.693	2.92	0.74		
	Revenue	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
	SDE	200,000	200,000	200,000	200,000	200,000	200,000
	ROS	20.00%	20.00%	20.00%	20.00%	20.00%	20.00%
	Predicted Value	627,085	693,312	583,231	738,243	731,213	670,788
C1	**Subject Company (Above Average Revenue, SDE and ROS)**						
Same SDE, Different Revenue	Multiplier	2.830	0.875	2.92	0.74		
	Revenue	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000
	SDE	300,000	300,000	300,000	300,000	300,000	300,000
	ROS	30.00%	30.00%	30.00%	30.00%	30.00%	30.00%
	Predicted Value	849,038	875,158	874,846	738,243	731,213	855,663
C2	**Subject Company (Below Average Revenue, Above Average SDE and ROS)**						
Same SDE, Different Revenue	Multiplier	2.525	1.057	2.92	0.74		
	Revenue	750,000	750,000	750,000	750,000	750,000	750,000
	SDE	300,000	300,000	300,000	300,000	300,000	300,000
	ROS	40.00%	40.00%	40.00%	40.00%	40.00%	40.00%
	PredictedValue	757,448	792,754	874,846	553,682	590,343	855,663

Mark G. Filler, CPA/ABV, CBA, AM, CVA is President of and heads Filler & Associates' valuation and litigation and support practice. He was recently chair of the editorial board of The Value Examiner *and coauthor of NACVA's quarterly marketing newsletter* Insights on Valuation. *Filler has published various articles on valuation and commercial damages, and is the coauthor of* A Quantitative Approach to Commercial Damages: Applying Statistics to the Measurement of Lost Profits *published by John Wiley & Sons.*